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ABSTRACT

This document presents the revised Arkansas Science Curriculum Framework (1999), which replaces the Science Curriculum Framework of 1994. Three strands--physical science systems, life science systems, and Earth science/space science systems--were identified using an integrated approach to provide guidance in the science curriculum. A glossary and science learning scenarios are included. (YDS)

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ED 469 094

Science Curriculum Framework
Revised 1999

Strand 1: Physical Systems **Strand 2: Life Science Systems** **Strand 3: Earth/Space Systems**

All "Student Learning Expectations" should be considered cumulative. That is, all "Student Learning Expectations" from preceding or earlier grade levels may be used at any time by curriculum planners creating curriculum at a specific grade level.

The Science Curriculum Framework (1999) has been revised from five to three strands and replaces the Science Curriculum Framework of 1994. The intent of this document is to guide local curriculum toward more hands-on learning activities with increased emphasis on problem solving. An effort to integrate performance assessments into instructional events is encouraged. This framework incorporates a greater use of writing-to-learn and the use and application of mathematics in the science curriculum. The *Standards for Accreditation of Arkansas Public Schools* requires three units of science for graduation. At least one science shall be in a life science (biology) and one in a physical science (physical science, chemistry, physics, earth science, astronomy, geology, etc.). All required science units must provide hands-on laboratory experience for students a minimum of 20 percent of instructional time.

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Science Curriculum Framework

Revised 1999

The Nature of Science

People have many ways of knowing about their world including scientific knowledge, societal knowledge, religious knowledge, and cultural knowledge. Science differs from these other ways of knowing in important ways.

Science is a system of exploring the natural universe through data collected by **observation, experimentation**, and **peer verification**. This data must be reviewed by many scientists before it is accepted as valid evidence. Based on collected data, theories are advanced to explain and account for observations.

The success and credibility of science are anchored in the willingness of scientists to

1) Expose their ideas and results to independent testing and replication by other scientists. This requires the complete and open exchange of data, procedures, and materials.
2) Abandon or modify accepted conclusions when confronted with more complete or reliable experimental evidence.

Science definitions for the following terms are specific:

Fact: In science, an observation that has been repeatedly confirmed.

Hypothesis: A testable statement or prediction about the natural world which can be supported by experiment or observation.

Law: A descriptive generalization about how some aspect of the natural world behaves under stated circumstances, often stated in a form of a mathematical equation.

Theory: In science, a well-substantiated explanation of some aspect of how the natural world works that explains facts, laws, inferences, and tested hypotheses.

Before a theory can be included in the system of science, it must meet all of the following criteria:
(1) its ability to explain what has been observed;
(2) its ability to predict what has not yet been observed; and
(3) its ability to be tested by further experimentation and to be modified as required by the acquisition of new data.

These definitions mean that a scientific theory is not used, as people often use the word theory, to mean a hunch or a guess. A scientific theory is held with a high degree of confidence and is supported by enough evidence to make its abandonment unlikely. As new evidence is found, a theory may be modified but only with compelling evidence, verification, and peer review.

The National Science Teachers Association (NSTA) endorses specific guidelines that must be followed to determine what belongs in science education. NSTA supports the following:

I. Respect the right of any person to learn the history and content of all systems and to decide what can contribute to an individual's understanding of the universe and his/her place in it.

II. In explaining natural phenomena, science instruction should only include those theories that can properly be called science.

III. To ascertain whether a particular theory is properly in the realm of science education, apply the criteria stated above, i.e., (1) the theory can explain what has been observed; (2) the theory can predict that which has not yet been observed; (3) the theory can be tested by further experimentation and be modified as new data are acquired.

IV. Oppose any action that attempts to legislate, mandate, or coerce the inclusion in the body of science education, including textbooks, any tenets which cannot meet the above-stated criteria.

Science is not a matter of belief; rather, it is a matter of **conclusive evidence** that can be subjected to the test of observation, reasoning and peer review. The open competition of ideas in published papers is a major part of scientific work.

Science can only deal with events or things that can be measured, observed or detected. It cannot be used to investigate all questions. There are beliefs that cannot be proved or disproved by their very nature (e.g., the meaning of life or the existence of supernatural powers and beings). In other cases, a scientific approach that may be valid is likely to be rejected as irrelevant by people who hold certain beliefs (e.g., astrology, fortune-telling, and superstition). Scientists do not have the means to settle issues concerning good and evil. Answers to these questions must be found in religion, philosophy, cultural ideals, and other systems of beliefs.

In the past, science was often presented as a series of facts to be memorized. Today's instructors utilize such techniques as: hands-on lab experiences and inquiry activities, open-ended questions and problem solving, individual and group research, long and short term projects, interactive discussion and some lecture. Students need to realize how the scientific processes are used to acquire new knowledge. The best way for students to understand this is for them to spend time using scientific inquiry, experimentation, discussing data, drawing inferences based on data, and writing conclusions. These processes should be practiced in every science course. It is also desirable that students be aware of past scientific works that formed the basis for the development of present theories, and the fact that scientific theories are built on the sequential work of many scientists over time.

Students should be exposed to the learner expectations that cover the above ideas, the processes of science, and the science content of the framework.

Arkansas Department of Education

STRAND 1: PHYSICAL SYSTEMS CONTENT STANDARD 1 Students will demonstrate an understanding of physical systems as a process of inquiry. GRADES K-4 (Student Learning Expectations) PS.1.1. Examine the techniques of *scientific inquiry*: problem solving, questioning, reasoning, creative decision making by utilizing the *scientific method*. PS.1.2. Use simple equipment (microscopes), age-appropriate tools (rulers, thermometers), skills (describing and writing), technology (computers) and mathematics in scientific investigations. PS 1.3. Communicate designs, procedures, and results of scientific investigations (graphs, charts, and writings). <u>Assessment Legend</u>: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	Assessment Options and Possibilities 1. T, PR, D, LJ 2. O, D 3. PR, O, PE, W

STRAND 1: PHYSICAL SYSTEMS CONTENT STANDARD 2 Students will explore, demonstrate, communicate, apply, and evaluate the knowledge of physical systems. GRADES K-4 (Student Learning Expectations) PS.2.1. Recognize the differences and similarities of *solids*, *liquids* and *gases*. PS.2.2. Understand the physical properties of objects. PS.2.3. Learn about the physical world by observing, data collecting, using age-appropriate tools, describing, and hypothesizing. PS.2.4. Revise *hypothesis* by sharing and communicating observations through writing. PS.2.5. Explore energy changes. PS.2.6. Identify *chemical* and *physical changes*. PS.2.7. Classify simple machines and relate them to inventions and discoveries. PS.2.8. Explore the effects of applying various types of *forces* to an object (push/pull). PS.2.9. Identify and compare the relationships between *mass*, *weight*, *force*, and *motion*. PS.2.10. Examine properties, types, and uses of magnets. PS.2.11. Analyze and compare the relationship between magnets and electricity. PS.2.12. Experiment with *static* and *current electricity*. PS.2.13. Determine the relationship between vibration and sound. PS.2.14. Explore the properties of light (e.g., *reflection*, *refraction*, *absorption*, *translucent*, *transparent*, opaque). Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	Assessment Options and Possibilities 1. T, D, C 2. T, O, D 3. O, D, LJ 4. D ,L J, W 5. T, PE, W 6. T, E, LJ 7. O, PE, W 8. D, LJ, C 9. 9. O, W, PE 10. D, LJ, T 11. W, PE, E, T 12. D, O, LJ 13. D, PR, LJ 14. O, D, T

STRAND 1: PHYSICAL SYSTEMS CONTENT STANDARD 3 Students will demonstrate an understanding of the connections and applications of physical science. GRADES K-4 (Student Learning Expectations)	Assessment Options and Possibilities
PS.3.1. Understand that physical science is interwoven into the structure of all disciplines.	1. LJ, O
PS.3.2. Recognize that mathematics is the basis of communication in physical science.	2. E, LJ, O
PS.3.3. Understand that tools allow tasks to be done more easily.	3. T, O, PO
PS.3.4. Explore physical science related careers.	4. W, PR

STRAND 2: LIFE SCIENCE SYSTEMS CONTENT STANDARD 1 Students will demonstrate an understanding of life science as a process of inquiry. GRADES K-4 (Student Learning Expectations)	Assessment Options and Possibilities
LS.1.1. Utilize the *scientific method* to investigate life sciences.	1. PR, E, LJ
LS.1.2. Select age-appropriate equipment and utilize technology and mathematics in the inquiry of life science.	2. PR, D
LS.1.3. Generate graphs, writings, and charts to communicate life science investigations.	3. W, E
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 2: LIFE SCIENCE SYSTEMS CONTENT STANDARD 2 Students will explore, demonstrate, communicate, apply and evaluate the knowledge of life systems. GRADES K-4 (Student Learning Expectations)	Assessment Options and Possibilities
LS.2.1. Identify and compare characteristics of living and nonliving things. LS.2.2. Explore cells in *organisms*. LS.2.3. Identify and investigate the functions of body systems in *organisms*. LS.2.4. Recognize patterns and characteristics of *organisms*. LS.2.5. Explore the life cycles of *organisms*. LS.2.6. Name some common animals that no longer exist (e.g., dinosaurs and mammoths). LS.2.7. Understand that offspring are similar to their parents. LS.2.8. Identify the features of plants and animals that enable them to live in different environments. LS.2.9. Define and describe a *food chain* and a *food web*. LS.2.10.Understand that *organisms* are interdependent.	1. T, W, D 2. C, D, PO 3. D, T, W 4. C, LJ 5. T, D, LJ 6. T, C, W 7. C, W, E 8. T, W, C 9. PR, O 10. LJ, O, T

STRAND 2: LIFE SCIENCE SYSTEMS CONTENT STANDARD 3 Students will demonstrate an understanding of the connections and applications in life sciences. GRADES K-4 (Student Learning Expectations)	Assessment Options and Possibilities
LS.3.1. Understand that life sciences are interwoven into all disciplines. LS.3.2. Recognize that mathematics is the basis of communication in life science. LS.3.3. Identify that humans change environments in ways that can be beneficial or detrimental for themselves and other *organisms*. LS.3.4. Explore careers related to life sciences. Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	1. LJ, O 2. E, LJ, O 3. PR, C, LJ 4. W, PR

STRAND 3: EARTH/SPACE SYSTEMS CONTENT STANDARD 1 Students will demonstrate an understanding of the inquiry process through the study of Earth and space systems. GRADES K-4 (Student Learning Expectations)	Assessment Options and Possibilities
ES.1.1. Utilize the *scientific method* to investigate Earth/space systems.	1. PR, E, LJ
ES.1.2. Select appropriate equipment and utilize technology and mathematics in the inquiry of Earth/space systems.	2. PR, D
ES.1.3. Generate graphs, writings, and charts to communicate Earth/space systems investigations.	3. W, E

STRAND 3: EARTH/SPACE SYSTEMS CONTENT STANDARD 2 Students will explore, demonstrate, communicate, apply and evaluate knowledge of the properties of Earth and space systems. GRADES K-4 (Student Learning Expectations)	Assessment Options and Possibilities
ES.2.1. Recognize and classify different types of Earth materials.	1. PE, O, PO
ES.2.2. Describe major features of the Earth's surface and how it is affected by natural changes.	2. T, D, W
ES.2.3. Identify the natural divisions of Arkansas.	3. E, C, PR
ES.2.4. Understand that the Earth is layered (*crust, mantle, core*).	4. T, E, W
ES.2.5. Investigate seasonal changes in weather and factors which affect weather conditions.	5. D, O, LJ
ES.2.6. Describe the *water cycle*.	6. PR, W, C
ES.2.7. Discuss land forms in the ocean and how they change.	7. T, D, W
ES.2.8. Analyze the features and motions of the sun, moon, and other celestial bodies (e.g., *solar system*, moon phases, Earth's *rotation* and *revolution*).	8. W, PE, E, T
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 3: EARTH/SPACE SYSTEMS CONTENT STANDARD 3 Students will demonstrate an understanding of the connections and applications of Earth and space systems. GRADES K-4 (Student Learning Expectations)	Assessment Options and Possibilities
ES.3.1. Understand the varied uses of water.	1. W, PR, PO, LJ
ES.3.2. Describe uses and conservation of materials taken from the earth.	2. W, T, PR
ES.3.3. Identify the effects humans have on the environment (e.g., use and misuse).	3. PE, D, W
ES.3.4. Understand how Earth/space systems connect to other disciplines.	4. LJ, O
ES.3.5. Recognize the importance of mathematics as the basis of communication in Earth/space systems.	5. E, LJ, O
ES.3.6. Use age-appropriate equipment, tools, techniques, technology, and mathematics in *scientific investigation* of Earth/space systems.	6. PR, D
ES.3.7. Explore careers related to Earth/space science.	7. W, PR

STRAND 1: PHYSICAL SYSTEMS CONTENT STANDARD 1 Students will demonstrate an understanding of physical systems as a process of inquiry. GRADES 5-8 (Student Learning Expectations)	Assessment Options and Possibilities
PS.1.1. Understand that the laws of science are universal.	1. O, LJ ,W
PS.1.2. Understand that a scientific *theory* is based on current, accepted evidence and used to make predictions.	2. T, LJ, PR
PS.1.3. Generate written conclusions based on evidence acquired through experimentation.	3. PO, PR ,W
PS.1.4. Interpret scientific information from graphs and charts.	4. T, PR, LJ
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 1: PHYSICAL SYSTEMS	Assessment Options and Possibilities
CONTENT STANDARD 2 Students will explore, demonstrate, communicate, apply, and evaluate the knowledge of physical systems.	
GRADES 5-8 (Student Learning Expectations)	
PS.2.1. Demonstrate an understanding of the *states of matter* and describe the various combinations of matter (*mixtures* and *compounds*).	1. T, D, LJ
PS.2.2. Identify and describe the properties of an atom.	2. T, PO, D
PS.2.3. Investigate the *periodic chart*.	3. T, D, LJ
PS.2.4. Experiment and identify *physical* and *chemical changes*.	4. T, D, O
PS.2.5. Examine the sources and analyze the preservation of energy resources.	5. W, O
PS.2.6. Experiment with *forces* (*gravity*, *magnetism*, and *electricity*).	6. T, D, PR, PE
PS.2.7. Investigate the laws of motion.	7. D, T, O
PS.2.8. Demonstrate and communicate the relationship between magnetic fields and electric currents.	8. D, T, PE
PS.2.9. Introduce the *electromagnetic spectrum* (radio, infrared, visible light, and ultraviolet *waves*; x-rays).	9. PE, O, D
PS.2.10. Investigate and identify conductors and insulators of heat and electricity.	10.D, O, T
PS.2.11. Distinguish energy transfer (*conduction*, *convection*, *radiation*).	11. D, O, T
PS.2.12. Investigate sound *waves* and gamma rays.	12. D, O, T
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 1: PHYSICAL SYSTEMS CONTENT STANDARD 3 Students will demonstrate an understanding of the connections and applications of physical science. GRADES 5-8 (Student Learning Expectations) PS.3.1. Design and conduct different kinds of scientific investigations to answer different kinds of questions. PS.3.2. Demonstrate how physical science is connected to mathematics (analyze collected data). PS.3.3. Apply multiple strategies to problem solving. PS.3.4. Use appropriate equipment, tools, techniques, technology, mathematics, and technical writing in scientific investigation. PS.3.5. Investigate a variety of careers related to physical science. PS.3.6. Acknowledge the impact of scientific discoveries upon society. PS.3.7. Recognize that scientific discovery has been influenced by historical events.	Assessment Options and Possibilities 1. T, PO, C 2. D, T, LJ 3. PE, PO, LJ 4. C, D, O 5. W 6. W 7. W, O, PE

STRAND 2: LIFE SCIENCE SYSTEMS CONTENT STANDARD 1 Students will demonstrate an understanding of life science as a process of inquiry. GRADES 5-8 (Student Learning Expectations) LS.1.1. Recognize that science deals only with inquiry about the natural world. LS.1.2. Interpret scientific information from graphs and charts. LS.1.3 Conduct investigative science through use of the *scientific method.* LS.1.4. Generate conclusions based on evidence acquired through experimentation. Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	Assessment Options and Possibilities 1. T, O 2. T, W, PR 3. PR, W, D 4. LJ, W, PE

STRAND 2: LIFE SCIENCE SYSTEMS CONTENT STANDARD 2 Students will explore, demonstrate, communicate, apply and evaluate the knowledge of life systems. GRADES 5-8 (Student Learning Expectations) LS.2.1. Identify, describe, and explain various types of cells and cell processes. LS.2.2. Describe similarities and differences between single celled and multicellular *organisms*. LS.2.3. Arrange *organisms* into groups according to similarities and differences. LS.2.4. Identify the requirements for living *organisms*. LS.2.5. Explain life cycles of various *organisms*. LS.2.6. Describe the parts of the human body systems and determine their function. LS.2.7. Describe how heredity and environment influence/determine characteristics of an *organism*. LS.2.8. Recognize that reproduction is a characteristic of all living *organisms* and is essential to the continuation of life. LS.2.9. Explain how physical and/or behavioral characteristics of *organisms* help them to adapt and survive in their environments. LS.2.10. Describe how environmental changes and *genetic mutations* cause species to *evolve* over time, thus producing new species. LS.2.11. Analyze ecosystems in terms of population relationships, *food webs*, energy flow, and *biotic succession*. LS.2.12. Evaluate human impact on the environment. Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	*Assessment Options and Possibilities* 1. T, D, LJ 2. C, W 3. PE, D, T 4. C, T, PO 5. W, D, PO 6. W, D, T, PR 7. W, T, D 8. T, W 9. O, T, D ,LJ 10. W, T, O 11. D, T, PO 12. W, PO

STRAND 2: LIFE SCIENCE SYSTEMS CONTENT STANDARD 3 Students will demonstrate an understanding of the connections and applications in life sciences. GRADES 5-8 (Student Learning Expectations)	Assessment Options and Possibilities
LS.3.1. Design and conduct life science investigations to answer different kinds of questions.	1. PR, LJ, PE, E
LS.3.2. Correlate life science activities to other curricular areas (e.g., language arts, mathematics, social studies).	2. W, T, PO
LS.3.3. Apply multiple strategies to problem solving.	3. T, PO, D
LS.3.4. Use appropriate equipment, tools, techniques, technology, mathematics, and technical writing in scientific investigation.	4. D, O, T, C
LS.3.5. Investigate a variety of careers related to life sciences.	5. W, PO

STRAND 3: EARTH/SPACE SYSTEMS CONTENT STANDARD 1 Students will demonstrate an understanding of the inquiry process through the study of Earth and space systems. GRADES 5-8 (Student Learning Expectations)	Assessment Options and Possibilities
ES.1.1. Identify the components of Earth (rocks, water, and air) and their properties.	1. D, O, T
ES.1.2. Understand that Earth and objects in space constantly undergo changes and/or cycles which can be observed and measured.	2. D, O, T
ES.1.3. Generate conclusions based on evidence acquired through experimentation.	3. D, T
ES.1.4. Interpret scientific information from graphs and charts.	4. T, W, LJ
ES.1.5. Identify and classify rocks and *minerals*.	5. D, T
ES.1.6. Understand the relationship between Earth and objects in space.	6. O, T
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 3: EARTH/SPACE SYSTEMS CONTENT STANDARD 2 Students will explore, demonstrate, communicate, apply and evaluate knowledge of the properties of Earth and space systems. GRADES 5-8 (Student Learning Expectations)	Assessment Options and Possibilities
ES.2.1. Investigate the formation and properties of rocks (*igneous*, *sedimentary*, and *metamorphic*), *minerals*, and *fossils*.	1. D, T, PR
ES.2.2. Understand the relationship which exists between rock formation, fossil evidence, and geological history of the Earth and age of the Earth.	2. W, T
ES.2.3. Investigate how Earth's internal processes affect external features (volcanoes, earthquakes, mountain formation).	3. D, T
ES.2.4. Understand the effects of *weathering* and *erosion* on the Earth's surface.	4. O, T, LJ
ES.2.5. Describe and model the natural divisions of Arkansas.	5. D, PR, T
ES.2.6. Describe the energy transfer within the *atmosphere* as it relates to the development of weather and climate patterns.	6. W, T, D
ES.2.7. Explain and illustrate the *water cycle*.	7. D, W, PO
ES.2.8. Model and explain how the Earth's shape and tilt result in different seasons.	8. PE, O, D
ES.2.9. Investigate the predictable motion of objects in space in explaining phenomena such as day, night, moon phases, ocean tides, and eclipses.	9. T, W, D
ES.2.10. Analyze how the features of the oceans affect humans.	10. T, W, D
ES.2.11. Compare the ability to support life on Earth and other objects in space.	11. PO, LJ
ES.2.12. Explain and compare the properties (*gravity*, size, shape, distance, and color) of objects in the *solar system*.	12. D, T, W
ES.2.13. Explore past, present, and future space technology.	13. W, PO
ES.2.14. Relate the physical characteristics of the sun to other stars.	14. T, O, PO
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 3: EARTH/SPACE SYSTEMS	Assessment Options and Possibilities
CONTENT STANDARD 3 Students will demonstrate an understanding of the connections and applications of Earth /space systems.	
GRADES 5-8 (Student Learning Expectations)	
ES.3.1. Design and conduct scientific investigations to answer different kinds of questions.	1. T, PE, LJ
ES.3.2. Apply multiple strategies to problem solving.	2. T, PR, O, PE
ES.3.3. Use appropriate equipment, tools, techniques, technology, mathematics, and technical writing in scientific investigations.	3. D, O, T, C
	4. W, PO
ES.3.4. Investigate a variety of earth science related careers.	5. PR, D, W
ES.3.5. Construct models of earth science systems and make real world applications.	6. D, PR, LJ, T
ES.3.6. Analyze the impact of human activities on the Earth's *crust*, *hydrosphere*, *atmosphere*, and *biosphere* (e.g., climate change, *greenhouse effect*, global warming, ozone depletion, and *UV radiation*) and demonstrate methods of conservation and recycling of the Earth's resources.	7. W ,T 8. W, D, O 9. D, T, W
ES.3.7. Explore the impact of space technology on society.	10. T, D, PE
ES.3.8. Illustrate the positive and negative effects of human use of natural resources on Earth.	
ES.3.9. Measure weather conditions using appropriate equipment.	
ES.3.10. Calculate the gravitational forces of objects in space.	
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 1: PHYSICAL SYSTEMS CONTENT STANDARD 1 Students will demonstrate an understanding of physical systems as a process of inquiry. GRADES 9-12 (Student Learning Expectations) PS.1.1. Understand that science is a process based on the *scientific method* which leads to a deeper understanding of real world situations. PS.1.2. Follow procedures for a *scientific inquiry* using step--by--step instructions, mathematical formulas, flow diagrams, and/or sketches. PS.1.3. Develop and implement a workable *scientific inquiry* independently and with a group using *standard safety procedures*. PS.1.4. Evaluate the process that scientists use to construct and validate scientific *theory*, such as data collection, prediction, experimentation (controls and variables), bias elimination, and replication. PS.1.5. Make objective observations and perform error analysis on collected data. PS.1.6. Formulate valid conclusions. PS.1.7. Communicate and defend in writing a scientific argument. PS.1.8. Critique and interpret scientific data on charts and graphs. PS.1.9. Recognize that theories are models and may be revised when new data is introduced. PS.1.10.Understand the criteria for the formation of scientific *theory* and a scientific law. Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	*Assessment Options and Possibilities* 1. T, PO, W 2. T, O, PE, W 3. E, PR, D, W 4. T, W, PO, LJ 5. T, PR, W 6. T, P, W, LJ 7. W, PO, PR 8. T, C, R 9. T, W 10. T , W

STRAND 1: PHYSICAL SYSTEMS CONTENT STANDARD 2 Students will explore, demonstrate, communicate, apply, and evaluate the knowledge of physical systems. GRADES 9-12 (Student Learning Expectations)	Assessment Options and Possibilities
PS.2.1. Evaluate the historical and multi-cultural contributions to the scientific body of knowledge in physical systems (nature of light, falling objects, expanding universe, model of the atom, quantum physics, periodic table). Construct time lines.	1. T, W ,D
PS.2.2. Classify matter into *elements*, *compounds*, and *mixtures*. Classify mixtures as *heterogeneous* or *homogeneous* and separate *mixtures* into pure substances using procedures such as *distillation* or *chromatography*.	2. T, PE, C
PS.2.3. Explore various *physical* and *chemical properties* of matter such as density, specific heat, *viscosity*, *buoyancy*, and *reactivity*.	3. T, PE, PR
PS.2.4. Distinguish between *physical* and *chemical changes* that affect everyday life, such as hot and cold packs, light sticks, rusting, fireworks display, and water displacement.	4. T, PE, C
PS.2.5. Use models to show the structure and behavior of matter (includes *Rutherford's Gold Foil Experiment*, *sub-atomic particles*, *electron energy levels*, *quantum theory*, and *organic molecules*).	5. T, PE, W
PS.2.6. Understand the rationale of the *periodic chart*.	6. T, C, W
PS.2.7. Explain the relationship among *mole*, *chemical bonding*, and *molecular geometry* within chemical *compounds*.	7. T, PE, W, PR
PS.2.8. Demonstrate the relationships between *kinetic theory* and the *states of matter* (*gas laws*).	8. T, W
PS.2.9. Understand the representation of and energetics of chemical reactions (equation writing, types of reactions, *stoichiometry*, *reaction rates*, *equilibria* and *electrochemistry*).	9. T, PE, W, D
PS.2.10. Understand the nature of solutions (*solubility*, *concentrations*, *pH*, *acids/bases*, *colligative properties*, and *buffer solutions*).	10. T, PE, W, PR
PS.2.11. Define the four fundamental *forces* in nature (gravitational, electromagnetic, weak nuclear and strong nuclear).	11. T, PE, W, PR
PS.2.12. Analyze the aspects of motion (frame of reference, speed, velocity, acceleration, relativity, time and displacement), and distinguish between average, constant and instantaneous motion. (Demonstrate and evaluate motion graphically.)	12. T, PE, W, PR
PS.2.13. Investigate the aspects of two-dimensional motion (circular, *rotational* and projectile), momentum and impulse.	13. T, PE, W, PR
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 1: PHYSICAL SYSTEMS CONTENT STANDARD 2 Students will explore, demonstrate, communicate, apply, and evaluate the knowledge of physical systems. GRADES 9-12 (Student Learning Expectations)	Assessment Options and Possibilities
PS.2.14. Apply the laws of conservation to interactions of matter (momentum, *angular momentum*, *mass/energy*, and *electric charge*).	14. T, PE, W, PR
PS.2.15. Explain the relationship of matter and energy ($E= m c^2$).	15. T, W
PS.2.16. Recognize the relationships of *forces* and motion, applying *Newton's laws*, and use diagrams to analyze the *forces* on a system.	16. T, W, PE
PS.2.17. Examine the types of *waves* (transverse, longitudinal, standing, circular, electromagnetic), properties and characteristics of *waves* (*reflection*, *refraction*, *diffraction*, *interference*, pitch, frequency, and velocity), and how *waves* transfer energy.	17. T, PE, W 18. T, PE, W, O 19. T, D, W 20. T, W, D
PS.2.18. Investigate the properties and characteristics of light and different optical systems (lenses, mirrors, polarization filters, fiber optics, and lasers).	21. T, PE 22. T, PE, W
PS.2.19. Evaluate the concept of the duality of light exploring contributions of scientists such as DeBroglie, Schrodinger, and Heisenberg.	23. T, W, PE
PS.2.20. Investigate the *electromagnetic spectrum* and the derivation of emission and *absorption* spectra.	24. T, PE, W, PR
PS.2.21. Examine the properties of sound (pitch, frequency, and intensity) and other related aspects (earthquakes, shock *waves*, SONAR).	25. T, W, PE, PR
PS.2.22. Investigate electric and magnetic interactions and fields (poles, magnetic domains, charges, field lines, potential difference, *force* and Coulomb's Law).	
PS.2.23. Distinguish between direct and alternating current.	
PS.2.24. Analyze and evaluate the parameters of circuits applying Ohm's Law and use appropriate data collections and calculations (current, resistance, and voltage).	
PS.2.25. Analyze the interdependent fields of electricity and *magnetism* (electromagnets, motors, generators, and transformers).	
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 1: PHYSICAL SYSTEMS CONTENT STANDARD 3 Students will demonstrate an understanding of the connections and applications of physical science. GRADES 9-12 (Student Learning Expectations)	*Assessment Options and Possibilities*
PS.3.1. Analyze the role science plays in everyday life and compare different careers in the physical sciences.	1. T, D, W, E
PS.3.2. Evaluate long range plans for resource use and by-product disposal in terms of environmental, economic, and political impact.	2. T, C, W
PS.3.3. Assess current world issues applying scientific themes (suggested issues: global changes in climate, ozone depletion, *UV radiation*, natural resources, use of technology, and public policy).	3. T, W, PE, PO
PS.3.4. Understand that mathematics is the precise language of communication and problem solving in science (conversions logarithms, inverse square law, etc.). (Measure and calculate using *SI units*.)	4. T, W, PE
PS.3.5. Apply technology as appropriate tools for solving problems (electronic balances, computers, *pH meters*, *spectrophotometers*, *multimeters*, etc.).	5. PE, D, O, PR
PS.3.6. Assess the connections between pure science and applied science to the world of work by performing labs and activities common to the physical sciences.	6. D, W, O
PS.3.7. Understand broad themes of Project 2061. Such themes include systems, patterns of change, interactions, *energy equilibrium*, models, and scale (e.g., relative dimensions such as *solar system* size). (See http://www.project2061.org/)	7. T, W
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 2: LIFE SCIENCE SYSTEMS CONTENT STANDARD 1 Students will demonstrate an understanding of life science as a process of inquiry. GRADES 9-12 (Student Learning Expectations)	Assessment Options and Possibilities
LS.1.1 Understand that science is a process based on the *scientific method* which leads to a deeper understanding of real world situations.	1. T, PO, W
LS.1.2. Follow procedures for a *scientific inquiry* using step-by-step instructions, mathematical formulas, flow diagrams, and/or sketches.	2. T, O, PE, W 3. PR, D, W, E
LS.1.3. Develop and implement a workable *scientific inquiry* independently and with a group using *standard safety procedures*.	4. PR, D, W, E 5. T, W, LJ
LS.1.4. Evaluate the process that scientists use to construct and validate scientific *theory*, such as data collection, prediction, experimentation (variables, control), bias elimination, and replication.	6. PR, T, W, LJ 7. W, PO, PR
LS.1.5. Make objective observations and perform error analysis on collected data.	8. C, W, T 9. T, W
LS.1.6. Formulate valid conclusions.	10. T, W
LS.1.7. Communicate and defend in writing a scientific argument.	
LS.1.8. Critique and interpret scientific data on charts and graphs.	
LS.1.9. Recognize that theories are models and may be revised when new data are introduced.	
LS.1.10. Understand the criteria for the formation of scientific *theory* and a scientific law.	
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 2: LIFE SCIENCE SYSTEMS CONTENT STANDARD 2 Students will explore, demonstrate, communicate, apply and evaluate the knowledge of life systems. GRADES 9-12 (Student Learning Expectations)	Assessment Options and Possibilities
LS.2.1. Evaluate the historical developments of, and cultural contributions to the scientific body of knowledge (e.g., biochemistry, food science, genetics, blood typing).	1. W, T
LS.2.2. Investigate and identify cellular processes, including *homeostasis*, permeability, energy production, transportation of molecules, disposal of wastes, function of cellular parts, synthesis of new molecules, and cell division.	2. T, D, O, W 3. T, W, D 4. T, D
LS.2.3. Understand that *DNA* is the basis for genetic transfer (*Mendel's laws*, genetic engineering, *DNA* replication, genetic disorders, reproduction and development in various life forms).	5. T, D 6. T, D 7. T, W
LS.2.4. Compare genetic variations observed in plants and animals (adaptations and mutations).	8. T, W
LS.2.5. Identify and describe the relationships between internal feedback mechanisms in the maintenance of *homeostasis*.	9. T, W, D 10. T, W
LS.2.6. Compare and contrast life cycles of familiar *organisms* (sexual, asexual, metamorphosis, and *alternation of generations*).	11. D, W, O 12. W, T, LJ
LS.2.7. Understand that all living things contain similar genetic material that *evolves* because of gene mutation, *natural selection*, and change in environments. Species change through time, and new life forms *evolve*.	13. D, W, O, E 14. T, D, O
LS.2.8. Analyze levels of organization in the human body systems (atoms, molecules, *organelles*, cells, tissues, and organs).	15. D, O, PO, E
LS.2.9. Analyze relationships among *organisms* and develop a model of a hierarchical classification system based on similarities and differences using *taxonomic nomenclature*.	
LS.2.10. Interpret interactions among *organisms* exhibiting predation, parasitism, *commensalism*, and *mutualism*.	
LS.2.11. Investigate and formulate solutions to problems resulting from human impact on the environment.	
LS.2.12. Analyze the flow of energy through various cycles including the carbon, oxygen, nitrogen and *water cycles*.	
LS.2.13. Investigate and explain the interactions in an ecosystem including *food chains*, *food webs*, and food pyramids.	
LS.2.14. Interpret the functions of systems found in living *organisms* (e.g., circulatory, digestive, nervous, endocrine, reproductive, *integumentary*, skeletal, respiratory, muscular, excretory, and immune).	
LS.2.15. Compare cells from different parts of plants including roots, stems, and leaves, to show specialization of structure and function.	
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

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STRAND 2: LIFE SCIENCE SYSTEMS	Assessment Options and Possibilities
CONTENT STANDARD 2 Students will explore, demonstrate, communicate, apply and evaluate the knowledge of life systems.	
GRADES 9-12 (Student Learning Expectations)	
LS.2.16 Draw and label the structures of viruses. Relate the structure of viruses to their abilities in causing diseases and conditions such as acquired immune deficiency syndrome, common colds, smallpox, influenza, and warts.	16. O, PE
LS.2.17. Identify the structures of bacteria and describe the multiple roles of bacteria in maintaining health such as digestion and causing diseases such as streptococcus infections and diphtheria.	17. S, T, O, W
LS.2.18. Understand that responses to external stimuli can result from interactions with an *organism's* own species, with other species, and with environmental changes (innate or learned).	18. S, T, PR, D, W
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 2: LIFE SCIENCE SYSTEMS CONTENT STANDARD 3 Students will demonstrate an understanding of the connections and applications in life sciences. GRADES 9-12 (Student Learning Expectations)	Assessment Options and Possibilities
LS.3.1. Analyze the role science plays in everyday life and compare different careers in the life sciences. LS.3.2. Evaluate long range plans for resource use and by-product disposal in terms of environmental, economic, and political impact. LS.3.3. Assess current world issues applying scientific themes (suggested issues: population growth, global changes in climate, ozone depletion, *UV radiation*, natural resources, use of technology, and public policy). LS.3.4. Understand that mathematics is the precise language of communication and problem solving in science. LS.3.5. Apply technology as appropriate tools for solving problems (microscopes, *centrifuges*, *flex cameras*, computers, etc.). LS.3.6. Assess the connections between pure science and applied science to the world of work by performing labs and activities common to the life sciences. LS.3.7. Understand broad themes of Project 2061. Such themes include systems, patterns of change, interactions, *energy equilibrium*, models, and scale (relative dimensions of the inclusions in a cell). (See http://www.project2061.org/)	1. D, LJ, T, W, E 2. T ,W, C 3. W, PE, PO 4. T, W, PE 5. D, O, PR, PE 6. TD, W, O 7. T, W
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 3: EARTH/SPACE SYSTEMS	Assessment Options and Possibilities
CONTENT STANDARD 1 Students will demonstrate an understanding of the inquiry process through the study of Earth and space systems.	
GRADES 9-12 (Student Learning Expectations)	
ES.1.1. Understand that science is a process based on the *scientific method* which leads to a deeper understanding of real world situations.	1. T, W, PO
ES.1.2. Follow procedures for a *scientific inquiry* using step-by-step instructions, mathematical formulas, flow diagrams, and/or sketches.	2. T, O, PE, W 3. PR, D, W, E
ES.1.3. Develop and implement a workable *scientific inquiry* independently and with a group using *standard safety procedures*.	4. T, W, LJ 5. T, PR, W
ES.1.4. Evaluate the process that scientists use to construct and validate scientific *theory*, such as data collection, prediction, experimentation (controls and variables), bias elimination, and replication.	6. PR, W, T, LJ 7. W, PO, PR
ES.1.5. Make objective observations and perform error analysis on collected data.	8. C, T, W 9. T, W
ES.1.6. Formulate valid conclusions.	10. T, W
ES.1.7. Communicate and defend in writing a scientific argument.	
ES.1.8. Critique and interpret scientific data on charts and graphs.	
ES.1.9. Recognize that theories are models and may be revised when new data is introduced.	
ES.1.10. Understand the criteria for the formation of scientific *theory* and a scientific law.	
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 3: EARTH/SPACE SYSTEMS CONTENT STANDARD 2 Students will explore, demonstrate, communicate, apply and evaluate knowledge of the properties of Earth and space systems. GRADES 9-12 (Student Learning Expectations)	Assessment Options and Possibilities
ES.2.1. Evaluate the historical and multicultural contributions to the scientific body of knowledge in the earth and space sciences. Topics may include expanding universe, *plate tectonics*, composition of the Earth and stars, and geologic time; and the works of Galileo, Copernicus, Kepler, and Wegener.	1. W, D ,E
ES.2.2. Understand that the sun is the source of energy for the *solar system*.	2. T, W, E
ES.2.3. Explain how Earth's energy and materials are conserved, interrelated, and recycled; include ores, and the following cycles--water, oxygen, carbon, and nitrogen.	3. T, W, E
ES.2.4. Explain the features of the Earth's composition and geological phenomena. Utilize the *plate tectonics*, the *continental drift*, and the *sea-floor spreading* theories.	4. T, C, W
ES.2.5. Analyze the composition and categorize types of rocks and *minerals*. Use *Moh's Hardness Scale* and the *rock cycle*.	5. PE, D, O
ES.2.6. Perform chemical analysis and classification of soil samples (*pH* or NPK).	6. D, O, W
ES.2.7. Examine origins of the natural land divisions of Arkansas in view of the earth formations (soil and rock) peculiar to that division.	7. LJ, C, PE
ES.2.8. Investigate the characteristics of oceans such as composition, features, *waves*, and energy transfer resulting from the currents.	8. W, T
ES.2.9. Evaluate the physical interactions of water with the Earth (glaciers, *erosion*, and *leaching*).	9. D, T, W
ES.2.10. Evaluate weather and climate, globally and locally, as a result of a complex exchange of heat energy (clouds, solar *radiation*, ocean currents, *gases*, *Coriolis effect*, human activities, jet stream, *El Nino*, etc.).	10. E, T, W
ES.2.11. Given measurements of weather conditions, relate them to the temperature, pressure, density, *ideal gas law*, and *buoyancy* of air.	11. C, W, T
ES.2.12. Interpret the features on weather maps and predict future conditions.	12. T, D, LJ
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 3: EARTH/SPACE SYSTEMS CONTENT STANDARD 2 Students will explore, demonstrate, communicate, apply and evaluate knowledge of the properties of Earth and space systems. GRADES 9-12 (Student Learning Expectations)	Assessment Options and Possibilities
ES.2.13. Compare Earth's sun to other stars in size, *mass*, temperature, energy source, position on *HR diagram*, and stages in a star's existence.	13. T, W, PE
ES.2.14. Locate common *constellations*.	14. T, W, PE
ES.2.15. Describe the organization of the known universe (*solar system*, galaxy, cluster, supercluster).	15. W, T, PO
ES.2.16. Analyze the impact of modern technology on the study of the Earth and universe (telescopes, space probes, robotic arms, weather satellites, *Doppler radar*, sonar, seismographs).	16. W, LJ
Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	

STRAND 3: EARTH/SPACE SYSTEMS CONTENT STANDARD 3 Students will demonstrate an understanding of the connections and applications of Earth/space systems. GRADES 9-12 (Student Learning Expectations) ES.3.1. Analyze the role science plays in every day life and compare different careers in the Earth/space sciences. ES.3.2. Evaluate long range plans for resource use and by-product disposal in terms of environmental, economic and political impact (human activities vs. resource quality). ES.3.3. Assess current world issues applying scientific themes (e.g., global changes in climate, ozone depletion, *UV radiation*, natural resources, use of technology, and public policy). ES.3.4. Understand that mathematics is the precise language of communication and problem solving in science. ES.3.5. Apply technology as appropriate tools for solving problems (electronic balances, computers, digital cameras, *pH meters*, *spectrophotometers*, telescopes, barometers, etc.). ES.3.6 Assess the connections between pure science and applied science to the world of work by performing labs and activities common to the Earth/space sciences. ES.3.7. Understand broad themes of Project 2061. Such themes include systems, patterns of change, interactions, *energy equilibrium*, models, and scale (relative dimensions such as *solar system* size). (See http://www.project2061.org/) Assessment Legend: S: Statewide; T: Teacher-made tests; PO: Portfolio; PR: Project; C: Checklist; O: Observation; PE: Performance; E: Exhibition; D: Demonstration; LJ: Log/Journal; W: Writing	*Assessment Options and Possibilities* 1. D, LJ, W, E 2. T, W, C 3. W, PE, PO 4. T, W, PE 5. D, O, PR, PE 6. D, W, O 7. T, W

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GLOSSARY

Absorption: When white light is passed through a substance, some of the light of certain colors may be absorbed (taken in) by the substance.

Acid: Corrosive, sour substance low in pH.

Alternation of Generations: Alternating sexual and asexual generation reproduction.

Angular Momentum: A measure of how difficult it is to start or stop a rotating object.

Atmosphere: The invisible blanket of air surrounding the Earth.

Base: Corrosive, slippery, bitter substance with a high pH.

Biosphere: The layer of the Earth in which life occurs naturally, extending to about 8 km above the Earth to the deepest part of the ocean, which is about 8 km deep.

Biotic Succession: The living parts of an ecosystem.

Buffer Solutions: A solution that has a constant pH.

Buoyancy: The upward force of a fluid.

Centrifuge: Spinning instrument used to physically separate mixture components.

Chemical Change: A change in matter in which one or more different kinds of matter are formed (burning, decaying, baking, rusting).

Chemical Bonding: The attractive force that holds atoms or ions together.

Chromatography: The separation of mixture by the use of adsorbing materials.

Colligative Properties: Properties of solution that depends on the number of dissolved particles.

Commensalism: A relationship in which one organism is helped and the other is not harmed.

Compounds: Chemical combinations of elements.

Concentrations: Ratio of one substance dissolved in another.

Conduction: The movement of energy within a substance by the transferring of energy from one particle to another.

Constellations: Groups or patterns of stars.

Continental Drift: Theory that all the continents were once connected and then moved apart.

Convection: Movement of matter and heat because of variations in density, usually resulting from temperature differences.

Core: The very hot solid and semisolid center of a planet or the inner part of a star where fusion takes place.

Coriolis Effect: Causes the apparent deflection of objects moving across Earth's surface, due to Earth's rotation.

Crust: The outer, lighter rock layer of a planet.

Current Electricity: Flow of electrons through a conductor.

Diffraction: Bending of waves.

Distillation: Separation of mixtures based on boiling points.

DNA: Cellular genetic material.

Doppler Radar: Detection of motion based on change in frequency of sound waves.

Ecology: The study of how living things are related and how they interact and depend on each other.

El Nino: Warm water current in the Pacific Ocean.

Electric Charge: Too many negative charges (negative) or too few negative charges (positive).

Electrochemistry: Current produced from ion transfer in a solution.

Electromagnetic Spectrum: All types of transverse waves that carry both electric and magnetic energy.

Electron Energy Levels: The arrangement of the electrons in an atom.

Elements: The most simple form of matter.

Energy Equilibrium: Balance of energy in a system.

Epicenter: Point on the Earth's surface directly above the focus of an earthquake.

Equilibrium: A natural balance of in a substance, chemical, organism, or system.

Erosion: Transportation of soil and rock by wind, water, gravity, and ice.

Evolve: The changing genetic makeup of a population or a species over time.

Experimentation: A test of a hypothesis in which data are gathered under controlled conditions.

Fact: An observation that has been repeatedly confirmed.

Fault-Block Mountains: Mountains formed along fractures on the Earth's crust where rocks have moved.

Flex Camera: Macro projector that attaches to a monitor for class observation.

Food Chain: The path by which energy passes from one living thing to another.

Food Web: All of the feeding relationships in an ecosystem.

Force: Any push or pull that tends to produce a change in the speed or direction of motion of an object.

Fossils: The remains or marks left by ancient life.

Gas Laws: Mathematical relationships of temperature, pressure, volume, and quantity of gas.

Gas: State of matter that has no definite shape or size and takes the shape of its container.

Gene Mutation: A change in the cellular genetic material that may cause a change in an organism. This change may have a positive or negative effect on the organism.

Gravity: The attraction of bodies toward the center of the Earth, moon, or other objects.

Greenhouse Effect: Warming effect on the air caused by heat rising from the surface of the Earth and being trapped by gases in the troposphere.

Habitat: An area that provides a living organism with food, water, shelter, and living space in a suitable arrangement.

Heterogeneous: Mixtures having different properties throughout.

Homeostasis: A state of steadiness. Equilibrium in living systems.

Homogeneous: Matter having similar properties throughout.

HR Diagram: Graph of stars according to temperature and brightness

Hydrosphere: All of Earth's water.

Hypothesis: A testable statement or prediction about the natural world that is based on what has already been learned and can be supported by experiment or observation.

Ideal Gas Law: Relationship between pressure, temperature, and volume.

Igneous: Rock formed by the solidification of magma.

Integumentary: Body's external covering.

Interference: Interaction of two quantities in a constructive or destructive manner.

Kinetic Theory: All particles are in constant motion.

Land Usage: The use of the land for man's purposes.

Leaching: Movement of materials down through soil layers.

Liquid: State of matter that has a definite size but no definite shape. It seeks the lowest level on Earth.

Magnetism: The force associated with some motion of electrical charges or by the field of force produced by a magnet.

Mantle: Rock layer between the crust and the core of a planet.

Mass: A measure of the amount of matter in an object.

Mendel's Laws: Principles governing genetics.

Metamorphic: Rock formed by the effect of heat, pressure, and chemical action on other rocks.

Mineral: A solid naturally occurring inorganic substance that is found in the Earth, always having the same properties and a regular

crystalline form.

Mixtures: Two or more substances physically combined.

Moh's Hardness Scale: Method to classify minerals based on hardness.

Mole: SI unit (Standard International System) for amount of substance.

Molecular Geometry: The spatial arrangement of atoms in a molecule.

Multimeters: Device for measuring electric current, voltage, and resistance.

Mutualism: Relationship in which both organisms benefit.

Natural Selection: A process by which populations change over time in response to changes in their environments as individuals better adapted to the new environmental changes leave more offspring.

Newton's Laws: The laws governing the motion of objects.

Observation: Information that is known from being seen or experienced directly through the use of technology

Organelles: Parts of cells.

Organic Molecules: Molecules containing carbon.

Organism: A living thing.

Peer Verification: Scientific studies are reviewed, analyzed, and discussed by scientists all over the world.

Periodic Chart: The organization of elements by atomic number into a table; similar elements are grouped in rows (periods) and columns (groups).

pH: An expression for the concentration of an acid.

pH meter: An instrument for measuring pH.

Photosynthesis: Process of converting light energy into chemical energy stored as glucose (food).

Physical Change: A change in the size, shape, or state of matter.

Plate Tectonics: Movement of the plates of Earth's crust.

Quantum Theory: Theory that radiant energy is transmitted in discrete amounts.

Radiation: Energy in the form of electromagnetic waves or particles.

Reaction Rates: The rate at which substances combine or disassociate.

Reactivity: A measure of ability of matter to combine.

Reflection: A change in the direction of a light ray as it bounces off an object.

Refraction: The bending of a light ray when it passes at an angle from one transparent substance into another transparent substance in which its speed is different (such as when it passes through air into water).

Revolution: The moving of a body in a circular course about a central point.

Rock Cycle: Continuous process of change in which new rocks are formed from old rock materials.

Rotation: Turning motion of an object on its axis.

Rutherford's Gold Foil Experiment: Proved atoms were made of space and had a nucleus.

Scientific Method: Organized procedure for investigation used by scientists.

Scientific Inquiry: Using the scientific method to answer questions.

Sea-Floor Spreading: Separating of ocean floor for emerging lava that results in producing new ocean floor.

Sedimentary: Rock formed in layers from sediment.

SI Units: Standard International System of measurements.

Solar System: A star and all the celestial bodies revolving around it.

Solid: A state of matter having a definite size and shape.

Solubility: Expression of the amount of solute dissolved in a solvent.

Species: a group of organisms that look alike and are capable of producing fertile offspring in nature.

Spectrophotometer: Quantitative instrument used to distinguish color intensities between variables.

Standard Safety Procedures: Recommendations found in the ***Laboratory Safety Guide for Arkansas K-12 Schools.***

States of Matter: Solids, liquids, gases, plasma.

Static Electricity: A form of electricity in which the electric charges are stationary.

Stoichiometry: Mathematical relationships in balanced chemical equations.

Subatomic Particles: Protons, electrons, neutrons, quarks, etc. found in an atom.

Taxonomic Nomenclature: Naming of organisms using the genus and species names.

Theory: A well-substantiated explanation (model) about how of some aspect of the natural world works that explains facts, laws, inferences, and tested hypotheses.

Translucent: Something that allows the passage of light but cannot clearly be seen through, e.g., frosted glass.

Transparent: Something that lets light through and which can be seen through clearly.

UV Radiation: Ultraviolet energy.

Viscosity: Resistance to flow.

Water Cycle: The continual process in which water moves between the atmosphere and the earth.

Waves: Mode of energy transfer.

Weathering: The processes that break apart and change rock.

Weight: The pull of the Earth on an object.

Science Learning Scenarios

These scenarios are provided as examples that demonstrate how concepts in the Strands and Content Standards *could* be taught. These examples are <u>not</u> exhaustive of instructional possibilities available to teachers.

GRADES K-4

Strand 1: Physical Systems
Content Standard 1
Students will demonstrate an understanding of physical science as a process of inquiry.

Mr. E gives his class a science experiment which follows the *scientific method* of discovery. He gives them a 16-ounce bottle of clear *liquid*. Working independently or in cooperative groups, students hypothesize whether the content of the bottle is water. The students experiment with the *liquid* using their five senses. When the bottle is opened, the students hear the rush of carbon dioxide. Mr. E refers his students to their original *hypothesis* for evaluation. The students continue using their other senses to collect data and record the results formulating a new *hypothesis*. A conclusion based on the data collected is drawn. Utilizing the *scientific method* of discovery during experimentation, students will discover that science is a process.

Strand 1: Physical Systems
Content Standard 2
Students will explore, demonstrate, communicate, apply, and evaluate the knowledge of physical systems.

Scenario One
Mrs. D has students work cooperatively and independently on activities to explore, demonstrate, communicate, apply, and evaluate. She also has students write about their learning. Example: To introduce a unit about a simple machine, Mrs. D uses a fishing rod and reel to demonstrate the use of a wheel and axle . She attaches a weight to the end of a fishing rod and raises the weight hand-over-hand without using the reel. Then she uses the reel to raise the object. Each student performs the experiment and records in his journal the answer to the question, "Which way was easier?"

Scenario Two
In her unit on Earth's *water cycle* systems, Mrs. L demonstrates how precipitation forms by placing ice cubes in a metal pie plate and heating

water in a teakettle of water until it steams. She holds the metal pie plate over the teakettle spout, and the steam from the spout reaches the bottom of the metal pie plate which is cooled by the ice cubes, thus causing rain to form. The students are able to observe a part of the *water cycle*. This experiment can be expanded to demonstrate how water can be changed physically (*solid, liquid, gas*). This experiment also can be expanded (Earth/Space Systems) to demonstrate how water causes land changes through erosion by placing a sloping pan filled with soil under the rain. Students write about their learning in their journals.

Strand 1: Physical Systems
Content Standard 3
Students will demonstrate an understanding of the connections and applications of physical science.

Scenario One
Students will demonstrate an understanding of the connections and applications of physical science by performing experiments, following the *scientific method*, recording data in science journals, and participating in projects for demonstrations, observations, and exhibitions. Mr. E. has his students keep science journals in which they use the *scientific method* of discovery to record the science experiments done in class. He has each student choose an experiment of his own for which he can create an exhibit for the school science fair. Mr. E has each student demonstrate his exhibit to the class and explain his conclusions.

Strand 2: Life Science System
Content Standard 1
Students will demonstrate an understanding of life science as a process of inquiry.

Scenario One
Mrs. D's students use the *scientific method* to discover the kind of environment earthworms like best. In cooperative learning groups, students consider several variables that affect earthworms--moisture, light, and temperature. Mrs. D encourages the students to focus on one variable at a time. The students set up their experiment and record the results in their science journals. Then the students design a science fair exhibit using journal notes. More in depth information about this activity can be found at http://books.nap.edu/html/nses/html/earthworms3.html (National Education Standards).

Strand 2: Life Science Systems
Content Standard 2
Students will explore, demonstrate, communicate, apply, and evaluate the knowledge of life systems.

Scenario One
To explore the life cycle of a butterfly, Mrs. L ordered caterpillars from a biological supply house. The students measured the caterpillars daily and recorded their findings. Students predicted the number of days necessary for the caterpillars to turn into the chrysalis stage and the number of days before they emerged as butterflies. Students recorded in their log/journals the complete cycle using writings, drawings,

and graphs. The students then compared their predictions with the average number of days it takes for a caterpillar to change to the chrysalis and from chrysalis to butterfly.

Scenario Two

Protective coloration is an identifiable feature of animals that enables them to hide from predators or become more effective hunters. Mr. B teaches this concept by coloring and hiding twenty one (5 ½ X 7) index cards in his classroom. At least 1/3 or more of the card must be visible. The students keep a log/journal record of where they find the hidden cards. They cannot move anything in the room during their investigations. Mr. B has his students research and report on animals that use protective coloration in their environments. Their research is recorded in their journals.

Strand 2: Life Science Systems

Content Standard 3

Students will demonstrate an understanding of the connections and application in life sciences.

Scenario One

Life sciences are integrated with other disciplines. To demonstrate this concept during her Arkansas history lesson, Mrs. C. invites guest speakers who have careers related to life sciences (e.g., forestry ranger, Arkansas Game and Fish Commission officer and a farmer). Each speaker's main task is to explain how humans change environments in ways that can be detrimental for themselves and other *organisms*. Students summarize the explanations in their journals and write short stories about how man affects the planet.

Strand 3: Earth/Space Systems

Content Standard 1

Students will demonstrate an understanding that Earth/Space Systems are processes of inquiry.

Scenario One

To demonstrate that Earth/Space Systems are processes of inquiry, Mr. E's students bake multilayered or marbleized cupcakes and then insert four clear straws vertically to take cross sections of the cupcakes (core samplings). Then they draw in their journals their predictions of how they think the cupcakes look inside. Last the students cut the cupcakes in half vertically to check their predictions.

Strand 3: Earth/Space Systems

Content Standard 2

Students will explore, demonstrate, communicate, apply, and evaluate the knowledge of the properties of Earth and space systems.

Scenario One

In her earth science unit, Ms. T demonstrates how the Earth is made up of layers by having her students cut hard-boiled eggs in half vertically. They then record their observations in their journals.

Scenario Two

Mr. B's his students construct a mobile of our *solar system* by using household supplies as a culmination to the study of the *solar system*.

Strand 3: Earth/Space Systems
Content Standard 3
Students will demonstrate an understanding of the connections and applications of Earth/space systems.

Scenario One
Ms. G's students record in their journals and graph their uses of water for a week. In a class discussion she has them determine when their water use was necessary and when it was wasteful. Then she has them evaluate the ways in which they could conserve water. Last, Ms. G has her class write letters to the Environmental Protection Agency requesting information regarding laws on water conservation.

GRADES 5-8:

Strand 1: Physical Science
Content Standard 1
Students will demonstrate an understanding of physical science as a process of inquiry.

Scenario One
Mrs. B has her students consider in cooperative groups whether beans grow better in light or dark. Provided materials for each group include two closable plastic bags with pre-soaked lima beans, paper towels, transparent tape, graph paper, a light source, and data-collecting tools. Students then write predictions in their journals and practice the *scientific method* in carrying out this experiment.

Strand 1: Physical Science
Content Standard 2
Students will explore, demonstrate, communicate, apply, and evaluate the knowledge of physical systems.

Scenario One
To demonstrate that the mass of an atom, though very small, is still mostly composed of space, Ms. C places a marble in the center of the 50-yard line on a football field. The marble represents the nucleus, and the outer energy level is represented by the seats farthest from the marble. This may also be done in a large parking lot or on a playground.

Scenario Two
Ms. Y demonstrates magnetic fields using white paper, iron filings, and magnets. She places different kinds of magnets (bar, horseshoe, round) on the white paper and sprinkles filings over the top of the paper to see the configuration of magnetic fields. Students record their

observations in their journals observations with drawings, and they identify both strong and weak areas of *magnetism*.

Strand 1: Physical Science
Content Standard 3
Students will demonstrate an understanding of the connections and applications of physical science.

Scenario One
To connect the science history to the present, Mrs. F provides students a list of contemporary and past scientists, Each student chooses a different person to research. The culminating activity is a "Scientists' Ball" for which students dress in costume to depict their selected scientist and issue invitations to the "ball" which are designed to highlight the individual□s characteristics, personality and contributions to science.

Strand 2: Life Science Systems
Content Standard 1
Students will demonstrate an understanding of life science as a process of inquiry.

Scenario One
Mr. B has students use and expand their investigative skills by exploring *habitats* they find on the playground. Each student is told to explore and evaluate a specific area to find ten signs which provide evidence that an animal uses the area (e.g., birds' nests, chewed leaves, animal droppings, and tracks). From this evidence, the students will infer which animals thrive in the particular *habitat*.

Strand 2: Life Science Systems.
Content Standard 2
Students will explore, demonstrate, communicate, apply, and evaluate the knowledge of life systems.

Scenario One
Utilizing cooperative grouping, Ms. C gives students butcher paper. One student lies on a large sheet of paper so that another can trace around him/her. On this outline, students will draw and label organs from each body system. They may follow this same procedure for several other *organisms* (e.g., dog, shark, turtle, frog, eagle). Students compare and contrast human systems to those of simpler *organisms*. This concept could be incorporated with certain seasonal activities such as drawing and labeling the various body systems within the outlined body of Santa Claus.

Strand 2: Life Science Systems
Content Standard 3
Students will demonstrate an understanding of the connections and applications of life science including current technology.

Scenario One
Mr. D has students evaluate options for wise use and management of land and examine the consequences of their decisions on the ecology. **Situation**: Two hundred-fifty acres of old growth forest were donated to a town with an ailing economy. Students are told to explore and investigate three major options for uses of this land. The first proposal is to maintain and manage the land as a protected area. The second proposal is to sell the land to a lumber company with a reputation for good forest management practices. The third option is to clear-cut the land to build a mall and new homes. The students research and develop a plan for best usage by utilizing community economics. Each group presents its proposal to the class, incorporating charts, graphs, and data to explain its recommendations.

Strand 3: Earth/Space Systems
Content Standard 1
Students will demonstrate an understanding of earth science as a process of inquiry.

Scenario One
Mrs. E assigns students to groups to explore earthquakes and how their proximity to the *epicenter* of a quake relates to severity of damage. Each group has a large paper box turned upside down on which a grid is drawn. The groups construct "buildings" with sugar cubes on designated locations on the grid. (Boxes /grids are teacher provided at the lower levels.) At the assigned point of the *epicenter* of the earthquake, one student taps with the eraser end of a pencil. Another student counts taps, as a third student records how many taps it takes for the structure nearest the center of the quake to fall and cause subsequent "damage" to other structures. This may be done a number of times to validate data. Students then write a summary of their findings. This activity also integrates various math skills.

Strand 3: Earth/Space Systems
Content Standard 2
Students will explore, demonstrate, communicate, apply, and evaluate knowledge of the properties of Earth and space systems.

Scenario One
Miss F stands eight dominoes on their short edges on a narrow strip of elastic. She slowly stretches the elastic and students observe what happens. She engages the students in a discussion of how the dominoes are similar to the building of *fault-block mountains.*

Scenario Two
Mr. G provides student groups with chalk and a few drops of lemon juice or vinegar. He engages the students in a discussion of the effects of chemical *weathering* (limestone deposits, lichen growth on rock, acid rain) on the Earth's surface through observation of how the *liquid*

affects the chalk.

Strand 3: Earth/Space Systems
Content Standard 3
Students will demonstrate an understanding of the connections and applications of Earth science including current technology.

Scenario One
As a culminating activity to the study of environmental conservation, Mrs. H directs the class to devise a written plan for recycling materials within the classroom. The students decorate containers and begin a class recycling program which could grow to be a school-wide project.
Scenario Two
Mr. I integrates math in his unit on space studies. He instructs older students to use calculations to figure their weights in relationship to the various planets by incorporating scientific formulas found in reference materials. Older students prepare charts and graphs of their findings and record them in their journals.. Younger students study and compare prepared charts and graphs.

GRADES 9-12

STRAND 1: Physical Science
CONTENT STANDARD 1
Students will demonstrate an understanding of the inquiry process through the study of physical science.

Ms. R arranges her students in groups of three or four students. She then gives them the following materials and instructions.
Materials: 3 transparent plastic cups, 100 millimeter graduated cylinder, dropper bottle of food coloring, 3 pipettes, marking pen, 3 different temperatures of water (room, cold and boiling), and insulated gloves
Safety: Caution students to use care in pouring hot water
Directions: Label each cup, A, B, and C respectively with a marking pen. Pour 100 milliliters of different temperature water in each cup as follows: room temperature water in cup A, cold (ice) water in cup B, and hot (boiling) water in cup C. Place 3 drops of food coloring in each cup simultaneously. Record your observations and based on those observations provide an explanation for the results.

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STRAND 2: Life Science

CONTENT STANDARD 1
Students will demonstrate an understanding of the inquiry process through the study of life science.

Mr. O begins his biology class stressing the *scientific method.* He proposes a question: How much fertilizer is needed for optimal growth of radishes? He assigns each team of students n allotment of fertilizer they would use on their radish seedlings. Students record in their science journals statistical information such as initial height measurements, color, leaf number and size. Equal exposure of light and water variables are agreed upon to avoid inconsistencies. Treatment of control seedlings is addressed and care is assigned to a group. Observations and measurements are made and recorded daily.
After two weeks, students review measured growth indications, compile data into graphs, and write their conclusions to the original question.

STRAND 3: Earth and Space Systems
CONTENT STANDARD 1
Students will demonstrate an understanding of the inquiry process through the study of Earth and space systems.

Students are given the following *minerals*: quartz, hematite, mica, olivine, pyrite, chalcopyrite, kaolin, talc, and shell ($CaCO_3$). The students are instructed to arrange the substances in order of hardness, beginning with the hardest to softest. They record their predictions. Students are then given a penny, a nail, steel file, and a piece of glass along with the instructions to perform scratch tests and to use the Moh's scale to assign a number for hardness.

STRAND 2: LIFE SYSTEMS
CONTENT STANDARD 2
Students will explore, demonstrate, communicate, apply and evaluate the knowledge of life systems.

Ms. S provides each pair of students the following items: two cellulose acetate dialysis tubes, 1 squeeze bottle containing 10% glucose solution, 1 squeeze bottle of 5% starch solution, 2 beakers, 2 large test tubes, 4 pieces of string, supply of glucose strips, and 1 dropping bottle of iodine solution (Lugol's). Ms. S tells the teams to predict which molecule/s--- the starch, water, or glucose--would diffuse across the cellulose acetate membrane. They record their prediction for future reference. Next, each team is instructed to follow the directions on a prepared handout showing the set up for osmosis. After 20 to 30 minutes, students record their observations and data in their science journals and discuss their findings.

STRAND 3: Earth Science
CONTENT STANDARD 2
Students will explore, demonstrate, communicate, apply, and evaluate knowledge of the properties of Earth and space systems.

Mr. R assigns a daily classroom activity of reviewing the computer weather maps on a given web site. After one week, Mr. R brings in the newspaper weather maps for that day. The students list and explain the various symbols on the map. Students work in groups. Each group is assigned a different geographical region and asked to present to the class their region's weather conditions for that day with a student acting as the meteorologist for that day. The group is asked to continue to monitor both computer and newspaper weather maps for the remainder of the week. Rotating the assignment, each group member will act as the daily meteorologist's voice to report that region's weather. Students record their data in a journal.

Physical Systems
Content Standard 2

Industry HiEd4U produces (PbI_2), a compound in demand globally. The company is, however, going broke! Your job is to investigate production problems and to increase efficiency. The following is a reaction that drives the industry:

$$2\ KI + Pb(NO_3)_2 \longrightarrow 2\ KNO_3 + PbI_2$$

Currently, the company uses 5.0×10^3 kg of KI and 5.0×10^3 kg of $Pb(NO_3)_2$ to produce PbI_2.

The company feels it must have a 50% recovery rate of the PbI_2. The officials are baffled! In your inspection, you will start at the beginning, asking the questions: "How much PbI_2 is expected?", "How much PbI_2 is actually recovered?", and "How can the plant increase production with the least problem?" Write an explanation of the problem (and solution) for the company board of directors.

STRAND 2: LIFE SYSTEMS
CONTENT STANDARD 3
Students will demonstrate an understanding of the connections and applications.

Ms. B provides her students with the following information about small pox:

- humankind's oldest and most devastating viral disease
- was wiped out by the vaccines
- last known outbreak was in Africa in 1977
- exists now in laboratory freezers
- last victim was in 1978 in England
- health organizations throughout the world agreed to destroy the last remaining smallpox virus-1993
- the USA still has samples stored at CDC as of 1999

Students use this information to answer the following questions in their science journals: What are some reasons for destroying the virus? Should these samples be destroyed? What are some reasons for preserving these samples? What would you do if you were responsible for this virus?

STRAND 3: Earth Science
CONTENT STANDARD 3

Students will demonstrate an understanding of the connections and applications of Earth/space systems.

Living in southeast Arkansas, Ms. K invites three earth science professionals from her local area to form a panel to discuss their education and work experience. The panel includes a civil engineer, a meteorologist, and a petroleum engineer. Students address the following considerations about the careers of these professionals in their journals:

1. List the job duties included in each profession.
2. Make a time line of each professional education background.
3. Choose one of these programs. Identify the high school and college courses a person would take to prepare for the selected career.

STRAND 1: Physical Systems
CONTENT STANDARD 3
Students will explore, demonstrate, communicate, apply, and evaluate the knowledge of physical systems.

Ms. K provides each team of students with the following materials: a convex lens, a concave lens, a meter stick, a candle, and a large piece of poster board. She discusses types of images, which will be either real (inverted) or virtual (upright). She tells students to note image size in comparison to the object size and image distance from the lens.

To begin, students do ray tracing for convex and concave lenses. The students light the candles and experiment with each lens to discover the images of the object (candle flame) produced. If the image is real, it can be projected onto the poster board. The students' findings are recorded in their journals.

Students measure and determine the focal length. They also measure the image distance relative to the object distance. They compare these measurements with the lens maker's equations and determine and record in their journals the percent error.

A follow-up discussion addresses size, type and quality of lenses as well as applications of lenses (e.g., correction of near-sightedness and farsightedness in the human eye, uses in telescopes, microscopes, projectors, etc.).

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